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PHOTOGRAMMETRIC ENGINEERING

Selecting the best imagery/ mapping products for your company

It is time to select new imagery for your GIS. How will you get the product you need and insure the company providing the imagery will meet your requirements?

Questions to be asked to determine your specifications:
What will the imagery be used for?
Will it be used for general planning only or engineering as well?
What do I expect to see?
What accuracy do I need?
Do we need topography?
What datum, coordinate system, and units of measurement do we need?
Who can provide the product that will best fit our needs?

To help you get the proper specifications, consider how you are going to use this information. Technical approaches for similar projects can differ significantly. The successful completion and delivery of the product you expect requires a clear definition of the specifications and expectations of your product.

Your specification list should include the following: boundary, photography type (B&W, color, infrared), accuracy and scale, orthophotography-pixel size, topographic mapping requirements- contour interval, planimetric information, existing field control or if you need all new provided, datum, coordinates and units for the mapping, and timetable for completion. If you can, include a budget, and state the priority of the deliverables you're requesting.

Boundary

The boundary needs to be very specific. It is best to provide a map outlining the boundary. Verbal descriptions over the phone or described in an e-mail often get misinterpreted. The boundary determines the layout of the flight plan and field control requirements, which in turn determines the cost.

Photography
Color has been the typical request in the last several years. The price is not as different as it used to be. It used to be 3-4 times what black and white was. Now it's less than 20% more. The biggest reason for this change is the increased speed of computer processors and software and the decreased price of digital storage devices. The increased price of black & white film is adding to this change also.

Physically the difference between color and black & white still is the amount of data in the final product. Color imagery is 3 times the size digitally as black and white. The content of the color imagery is greater also. There is a lot more information to be gleaned from color photography.

The time of year will always be a challenge as the angle of the sun effects the color spectrum and available light. During the middle of the summer the lighting is optimal and the window of the flight time is the longest.

Vegetation growth will affect how well the ground is seen. Typically you will want photography between snow on the ground season and leaves on the trees. The best time is determined by the weather patterns that year. Fall is best, but tricky because snow can come earlier than anticipated. Spring is surer but liable to have at least some leaves back on trees.

Humidity effects the quality of the photo. The more humid the air, the less crisp the photo will appear. Sometimes after a storm, even though it may be a nice sunny day, there is too much moisture to secure a quality photo.

Haze affectS the photo as well. If you see gunk in the air on a beautiful sunny day, so will the photography. Higher altitude photography is most effected by this problem.

Winter often has fewer flyable days than summer because of storms and snow cover. However, cold, crisp weather reduces humidity providing some extremely clear days.

Later fall and winter photography will have longer dark shadows on north facing slopes and it is more difficult to accurately guess the weather and snow fall. However fall is a good time to secure photography for water use information. The greenest lawns are usually on municipal properties.

Spring photos will give shorter shadows and it's easier to secure photography after the snow melts and before the leaves come out.

Though photography can work well taken anytime of the year, it is mostly luck and the gymnastics of scheduling around the weather that will enable us to take the photography for your project. The challenge to take quality photography is greatest in winter.

Accuracy and scale

This is probably one of the most important things to request. Scale has a direct relationship to accuracy both horizontal and vertical. The mapping accuracy is not necessarily related to plotting scale. But it is to the final mapping scale. The final mapping scale determines the flight height, which defines the photo scale. For example: 1"=100' mapping/orthophotography is typically taken from 1:6000 to 1:8000 photo scale. 1:7200 being the nominal photo scale for 1"=100' final mapping scale products.

Photography required to support a 6-inch pixel is lower, closer to the ground, than for a 1-foot pixel, the same for contours - the photography required to support a 2' contour is lower than for a 4 or 5-foot contour interval.

The following are scale, contour and pixel sizes normally produced from typical aerial photography scales:

1:3600	1"=50'	1' contour	0.25' pixel
1:7200	1"=100'	2' contour	0.5' pixel
1:12000	1"=200'	4' contour	1' pixel

The mapping you receive should meet a set standard of accuracy. There are 4 prominent ones: NMAS (National Map Accuracy Standards); NSSDA (National Standard for Spatial Data Accuracy); ASPRS (American Society for Photogrammetric and Remote Sensing) and US NCSSA (U.S. National Cartographic Standards for Spatial Accuracy). While they are similar in actual resultant specifications, let your photogrammetrist know which standard you will be holding to.

NMAS states that on clearly visible ground the contour accuracy be within ½ the contour interval (1’ for a 2’ contour map). It also states that for 90% of all planimetric features, which are well defined on the photographs shall be within one fortieth of an inch of their true position at map scale (2.5’ for 1”=100’). And that none of the features shall be misplaced by more than one twentieth of an inch (5’ for 1”=100’).

NSSDA is more stringent stating that both horizontal and vertical accuracy be at a 95% confidence level. This assumes that all systematic errors are eliminated.

ASPRS has 3 classes of accuracy. Class 1 is the most stringent, Class 2 can contain inaccuracies twice that of Class 1, and Class 3 errors can be triple those of Class 1.

US NCSSA- this is a set of standards with a multi-class choice, which is more suited to small-scale mapping (ie. 10’, 20’ contour interval).

Targets and control

Targets should be set on the ground (painted or taret material); the “cross, Y or T” is surveyed to establish northing and easting coordinates and elevation. Monument to ground measurements should be included in the survey report. Control is the base skeleton for the mapping. The accuracy of the control determines the accuracy of the rest of the map.

The number of targets is dependent upon the scale of the photography and the accuracy required. The tighter the accuracy the more control is required. For example for 1-foot contours at 1”=50’ scale or larger complete model control is typically used or the accuracy of the map can be compromised. 1”=100’ scale mapping with 2-foot contours required less ground control. It is supplemented however, with aerial triangulation.

Airborne GPS (global positioning system) can be used, which adds to the control network but cannot replace all of it. Airborne GPS locks into several navigation satellites to maintain a constant positioning record of the camera position, speed, date, time and altitude. IMU (inertial measurement unit) is a system that also helps further reduce the ground control required. IMU records the attitude (tilt) of the camera, speed variation and position. These systems supplemental the control but do not totally replace it.

If your photogrammetrist says they will not be using any ground targets or control because they would be using the GPS and IMU systems, be advised that the accuracy of your map may be compromised. Often buyers and end-users fail to understand the fundamental importance of sufficient control, datums and spatial quality assurance.

Datum and coordinate system

The datum is the geo-spatial data set putting the mapping in the place in “Space” that it belongs. For example the NAD 83 is the official horizontal datum for the United States. NAVD 88 is the official vertical datum. Other datums and/or local datums may be used.

The coordinate system is the system on which the coordinates are based. For instance State Plane Coordinate System (which is different for each state) puts your site in its proper place in the state. Other systems would be UTM and latitude and longitude.

Be sure to consider units of measure you require, whether the mapping will be in metric or English. If you are going with English, will the foot be US survey foot, US standard foor or international foot. Mixing metric and English cannot be done ie 1:500 scale with 2’ contours.

None of the datum options above affect the accuracy of the mapping. However, they can affect use with other projects(ie old information, neighbors information, if their projects are not in the same datum, coordinate system, or unit.

Pixel size

One of the first things generally considered is what pixel size will you need. <u>Make note that pixel size and accuracy are **not** synonymous</u>. The pixel size determines the resolution of the image.

Consider what you expect to see. Do you need to see utility information, i.e.: fire hydrants, water valves, storm drains? Do you need to see edge of paved road, sidewalks, fences and drainage information? Do you need to see the doghouse in the back yard or just the general layout of the property?

The smaller the pixel sizes the greater the resolving power of the digital image. In other words, if your project required visibility of manhole covers or fence lines, a pixel size of 3 feet wouldn't be very useful. Brush against fence lines might show, but the chance of having the manhole centered on a pixel would be unlikely. A pixel size of 6 inches would work well in this case.

Photography can be taken at an even smaller scale, ie: 1:12000 and scanned at a higher resolution or re-sampled to achieve a 6-inch pixel. The resultant image clarity is inferior to large scale photos. The actual image resolution will be significantly less than the 6-inch pixel taken from 1:7200 photography. The same accuracy will not be achieved. The scanning resolution has no effect on accuracy.

The more detail you expect to see, the smaller the pixel size should be. However, just because you asked for a 6-inch pixel doesn't mean they are all the same. Any scale of photography can be scanned to give you any size pixel you would like. It is important to also consider the accuracy you require before finalizing the pixel size. But the higher you fly the less you will see, even with samll pixels.

Conversely, a small pixel size may be of little use in undeveloped areas, such as forests and deserts. If in doubt, ask for some different samples from your photogrammetrist of projects similar to yours.

Orthophotography & imagery

The terms orthophotography, imagery and rectification are often used interchangeably today. This can be very misleading in communicating to the photogrammetrist what you are requiring.

Orthophotography is mapping. That is, it can be measured like a topographic map. It is tied to the ground by using surveyed field control. It is geo-referenced and can also be referenced to the topographic mapping that may be done with it.
Orthophotography is typically generated using overlapping aerial photographs to create a stereo model. This model is used to generate a DEM. This is in turn used to reconstruct the imagery, removing relief displacements and scale differences creating a uniform, scale image.

By definition orthophotography is tied to the ground. If no ground control is used for the generating an image, you will have imagery relative to itself, even if it was made with the same software orthophotography is made with. A digital image is not a map. It is a graphic representation of the ground.

With an orthophoto the features not at ground level may be displaced. This occurs because of the angle of the camera view at the time of the photograph. Features that change elevations sharply - ie: buildings, bridges/ overpasses, etc. are typically effected by this circumstance. These features can be corrected individually using difference processes available to the photogrammetrist. The expense for this service can be justified when the client's requirement is for communications engineering. Other applications may also benefit from this process.

This difference between orthophotography and imagery is that an orthophoto has a broader application for its use when compared to other digital imagery available for less or not tied to the ground, such as digital mosaics, which are rectified using USGS maps. The orthophoto can be accurately under-laid mapping, for GIS and other surveyed data as well as being useful for other engineering applications. The imagery can be an inexpensive tool for general planning.

Topography-contours

What contour interval is required for your city? A 2-foot contour interval is accurate enough for many engineering requirements. A 4-foot contour interval will give a good representation of the relief and would be adequate for general drainage studies.

The contour interval you specify has a major effect on the price and time required to completed a mapping project. The smaller the increment of the contour interval, the greater number of models required to accomplish mapping, and the higher price. However, if you need the tighter contour interval, it will be an invaluable resource.

When deciding on the contour interval take into consideration the relief of the land and how the map will be used. If the land is very flat you may need either a 2-foot or even a 1-foot contour interval, especially if it will be used for engineering and flood planning.

Within topographic mapping you can receive the mapping with DEM (digital elevation models) terrain elevation data collected in a grid pattern and provided in digital form. DTM (digital terrain model) is a 3-dimentional model of the ground using traditional breaklines, spot elevations and planimetry generated from these models and provided all together as a final product.

Generally today topography is compiled using analytical or softcopy photogrammetry software or computerized softcopy mapping using auto correlated DEM's. This auto-correlated mapping makes for faster turn-around. However, the information is computer averaged and not observed like the compiled mapping, which is typically more accurate.

Topography-planimetry

Typically the planimetry that is collected is that information which is clearly definable in the photography. At Olympus we have adopted the United States Department of Transportation 'Mapping Content Standards'. You can request that planimetric content, or more or less content. Just remember we need to be able to see the features you want collected on the photography. You can pre-mark utilities for collection if they're too small or obscure to see.

If you're on a strict budget, this is a place where you may be able to save money. By reducing or eliminating the planimetry you can free up funds to add orthophoto and contours in needed areas, relying on the orthophotography and possibly existing GIS information to depict the planimetry not collected.

Timetable for completion

As with most things the bigger and faster it is the more expensive it is. Keep this in mind when preparing for new imagery and mapping. The way to get the most for your dollars invested is to have the field control and photography taken in late summer or fall, request only your priority areas for quick delivery, and postpone the balance of the mapping products until late Winter. This way you can receive what you really need now quickly. For instance you may need all the orthophotography and only mapping along your project such as a new highway, mapping for a new subdivision, or utility corridor. This way you can take advantage of the lower rates that are charged in the off season.

Requesting what you need

Sometimes RFP's get very bogged down with the how to produce the product they want to receive, typically stating which hardware and software is to be used to produce the product. It is more important to address the detail of what you need to receive as a final product.

There are numerous types of hardware and software available to your photogrammetrist that will accomplish the same end result. There are many ways of collecting data. The geometry and general photogrammetric requirements are the same. Instruments may be a little different but as long as the end product has the same scale, accuracy and pixel size, you should receive the product you asked for.

The companies responding can determine the method and explain how it will meet your specifications. It is a good idea when you have a couple of firms in mind to visit their office and have them show you how they create their product.

Closing

Once again, your RFP request should reflect your specifications. Specify what you expect to receive from your provider. (Scale, accuracy and use), boundary, time of year for the photography, the datum, coordinate system you require and the units, and who will provide the targets and control. What format – AutoCAD, micro-station, etc. Do you need the DEM, DTM, and/or the contours, do you need the planimetry collected digitally (or will the ortho be sufficient), what media will the project be delivered on.

Did you receive what you asked for?

Trust but verify with field edits. Check for completeness and accuracy. Standard procedure dictates that photogrammetric maps be field checked prior to use. This is best done by selecting a few areas in the project to field check. If they checkout all right, you're probably ok with the balance of the project. If you find a problem call your photogrammetrist right away and they should be happy to work with you to correct the problem. Remember the photogrammetrist won't know there is a problem unless you let him know.